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Residential choices and interaction in three-member households: a choice experiment

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Abstract

Microeconomics studies group behaviour by using the representative member model. However, there is growing evidence that there can be significant differences between choices made by single individuals and those made by the same individuals when choosing collectively. This study investigates the differences between individual and joint decision-making in the context of residential location choice. It is widely recognized that household location choices involve several members of a household with heterogeneous preferences and influence power. Nonetheless little is known about group decision-making processes in practice. In particular, there is only scant evidence on how preferences differ among family members and to what extent individual preferences can be aggregated to achieve an approximation of joint choices. The study evaluates whether there is heterogeneity in single members' preferences. Furthermore, relative power is inferred by measuring similarity between *ex ante* single preferences and *ex post* joint choice outcomes. We also quantify the implicit bias generated by relying on the representative member approach. These issues are tested by employing a two-stage conjoint choice experiment administered to a sample of 53 Italian families. This work proposes a novel extension of the commonly used dyadic interaction approach to consider the role of adolescents in household decision-making.

Keywords: Unitary household, stated choice experiments, residential location, agent interaction and relative influence, discrete choice models, MNL, MMNL.
JEL. D12, C83, C35, D79

1 Introduction

Standard microeconomic theory treats the household as the basic decision unit, implicitly assuming either a representative agent preference structure or a unitary household utility function (Chiuri, 1999). Along these lines, empirical studies, employing Stated Preference (SP) techniques to study group behaviour have, with few exceptions, ignored potentially important issues inherent in multi-person choices. The lack of consideration behind the choice of the "appropriate" unit of analysis[1] may well generate biased welfare estimates and erroneous policy predictions (Adamowicz et al., 2005; Molin et al., 1999). Several recent studies have questioned the practice of treating group preferences as coincident with those of single members. This issue should be tested rather than assumed. There is clear evidence of both preference disparity between family members and dissimilarities between choices made individually and jointly (Bateman and Munro, 2005a; Beharry-Borg et al., 2009; Dosman and Adamowicz, 2006; Hensher et al., 2008; Lampietti, 1999). This paper tests the differences between single preferences, considering three distinct household member-types, and their joint choices of residential location by formulating three hypotheses:

First we investigate *preference heterogeneity* among family member-types by controlling whether the null hypothesis that all member-types have the same preferences for each attribute can be rejected.

Second, we test the validity of the *representative member hypothesis* in two different ways: 1) we control whether the joint household decisions can be represented by the average family preferences (*pooled model*) by means of a modified log-likelihood ratio test (Koppelman and Bhat, 2006), and, 2) we control whether we can reject the null hypothesis that any of the member-types has the same preferences of the family.

[1] This is testified by the commonly adopted *representative member hypothesis* where information is gathered from a single individual.

For the instances where the *representative member hypothesis* fails, we estimate the bias implied by the "wrong" choice of survey subjects. This bias is quantified in terms of WTP and WTA.

These hypotheses are tested by administering a two-stage conjoint SP experiment. This methodology represents a novel extension of the, nowadays common, dyadic interaction approach. In fact, in this paper we also consider the role adolescents play in household residential choice.

The paper is organized as follows. In the next section we review the literature on household decisions. Section 3 describes the base model of group choices and enunciates the hypotheses tested. Data and sample description are reported in section 4. Econometric results are presented in section 5. Section 6 concludes.

2 Research on household decisions

2.1 Microeconomics of household choices

Microeconomic analysis of family decisions originates from the consensus household model proposed by Samuelson (1956). Indeed, it is recognized that the household, not the individual, represents the basic consumption unit. A later contribution is Becker's rational choice approach to family-life. Even intimate decisions such as marriage, divorce, and family size are supposedly reached through weighing the pros and cons of alternative actions (Becker, 1993). Becker treats the family much like a tiny specialized factory engaging in household production of Z-goods like children, prestige and health (Becker, 1973). Over the last two decades, however, there has been a growing recognition that the unitary household model does not appropriately reflect the reality of household decision-making. The assumptions of the *beckerian* unitary household model (ranging from the single utility function to the single time and budget constraints) have failed numerous empirical tests (Browning and Chiappori, 1998; Thomas, 1990). Game theoretic bargaining models have challenged the unitary

approach. Here, household behaviour is the outcome of the interaction between heterogeneous members with distinct preferences (Manser and Brown, 1980; McElroy and Horney, 1981). In fact, only by treating each member as an independent heterogeneous entity can some form of bargaining take place. In essence, classic utility theory is not rejected *per se* but is regarded as inadequate for the analysis of household behaviour (Browning and Chiappori, 1998). In recent years, activity based analysis has produced rich developments of empirically based interactive models (Gliebe and Koppelman, 2002; Golob and McNally, 1997). In addition to such daily activity behaviour, concerning the coordination of activities among members, one can also observe relevant group-based decision-making in long-term decisions. Several studies analyse group decisions regarding residential choices (Molin et al., 1999), labour choices (Chiappori et al., 1998) car ownership (Hensher et al., 2008) and vacation choices (Kang and Hsu, 2005). The following sections deal with two essential features of empirical household decision-making research, namely, sampling strategies and influence analysis.

2.2 Sampling strategies for household analysis

When studying household choices it is standard practice, in SP studies, to ignore differences in preferences and power among members. It is possible to classify several strategies and their implications for the estimates derived thereby. Generally, empirical research adopts one of the following procedures:

1. *Randomly* interview a single member with no further attention to the appropriateness of the chosen respondent under the hypothesis that her choice is sufficiently similar to that of the family or, she is able to impose her choice on the household.
2. Apply the same assumption as the first procedure, but instead surveying a single *targeted* member following a specific procedure to individuate the most suitable respondent (for instance by interviewing the member paying the bills, based on the belief that this allows the researcher to identify the actual decision-maker).

3. Interview a single member that is asked to *represent* the preferences of the whole group.
4. Interview (only) the *whole household* based on the hypothesis that the choice is group-based and that only collective choices adequately represent real world ones.
5. Interview/compare both *single* and *group-based* preferences to verify the validity of the previous approaches and select the most adequate unit of analysis.

The first approach, namely an indistinct choice of respondent, assumes that any member-type is adequately qualified to represent the preference structure of the family as a whole. This method has become standard practice in SP choice modelling of residential location choice. It is equivalent to assuming that either differences among members are so small that they can be overlooked or they cancel out in the aggregate (Adamowicz et al. 2005). Alternatively, if one assumes the household to choose on the basis of a single utility function, then one can simply study the preferences of *any member* to gain an understanding of the household as a whole[2] (Browning and Chiappori, 1998; Lundberg et al., 1997). Overall there is no explicit selection procedure to find the most suitable respondent, neither is there any effort to distinguish single and joint responses.

The second approach is generally considered more accurate. It implies using a proxy to individuate the member considered the most influential or singularly responsible for a certain decision (Blood and Wolfe, 1960). One, *de facto*, assumes that there might be heterogeneity and power asymmetry but that a careful choice of the respondent can assure a correct representation of the household[3]. Since there is experimental evidence supporting the view that families make influential decisions jointly (Davis and Rigaux, 1974; Munsinger et al., 1975) one can arguably question the univocal and clear identification of the individual

[2] Arsenio et al. provide an illustrative example of this approach "*Each respondent was an adult who was asked to represent the household since this is the unit of decision making in the case of residential choice and the environmental attributes would impact on all household member.*" (2005, p. 19).

[3] An example of this procedure is reported in Jin et al. (2005, p 5) where the authors say: "*The head of the household was identified as the person in charge of the daily expenditures and other (younger) family members*.".

responsible for the decision. What is more, traditional indicators, such as relative income, may prove distorted proxies of the ability to influence choices (Corfman and Lehmann, 1987; Dosman and Adamowicz, 2006).

Based on these considerations one might adopt the third method for choosing a respondent, namely ask the respondent to represent the preferences of other member-types. Empirical findings show that, on the contrary, the ability of any one member to correctly assess the preferences of others is, in general, rather weak (Corfman and Lehmann, 1987; Dellaert et al., 1998; Menon et al., 1995). Corfman establishes that there is a lack of agreement among members when it comes to determining influence over joint choices (1989). Moreover, Dellaert et al. (1998) show how components of a household detain a limited ability to predict their own and others influence over joint choices.

The fourth approach suggests, based on the findings by Molin et al. (1999), to sample the whole group. This is expected to provide estimates with higher predictive accuracy. Applications in the residential literature include Ortùzar and Rodrıguez (2002), Pérez et al. (2003) and Galilea and Ortùzar (2005). This approach, however, produces no information concerning household components' likings. This hampers the comparative analysis of power differences within the family and does not make explicit disagreements and concessions.

In line with the fifth approach, this paper investigates the gap between individual and joint preferences. Past research indicates that there are large differences between individual and joint choice outcomes (Arora and Allenby, 1999; Corfman and Lehmann, 1993; Dellaert et al., 1998). Recent contributions use an experimental approach to model the differences between individual and joint choices (Bateman and Munro, 2009; Beharry-Borg et al., 2009; Carlsson et al., 2009; De Palma et al., 2008; Hensher et al., 2007). On the whole these findings indicate that individual choice data are not sufficient to produce representative and robust estimates of joint family decisions (Aribarg et al., 2002; Arora and Allenby, 1999;

Dosman and Adamowicz, 2006; Hensher et al., 2007; Menasco and Curry, 1989; Molin et al., 1997, 1999; Puckett and Hensher, 2006). There are simply more factors to consider such as influence, altruism, roles and resources at play that contribute towards shaping the final joint decision.

2.3 Decision-making in residential household choices

It is difficult to generalize findings from one context to another given that the level of interest, participation and influence among members are all shaped by the specific decision situation. Early examples of models considering multi-person residential choices are Timmermans et al. (1992) and Borgers and Timmermans (1993). The authors evaluate the influence of transport facilities on household residential choice in a two-stage experimental design that first examines individual choice then combines husband utility and wife utility based on a aggregation rule, to express the household utility. The work by Molin et al. (2001; 1997, 1999; 2000) is the closest to the present study. For example, Molin et al. (2001) capture preference heterogeneity among household members by individually interviewing each member of the 147 households participating in the study; whereas Molin et al. (1999) compare interactive group responses to conventional conjoint (single agents) to investigate the differences between individual and group preferences. The studies show that group-based models are better predictors of household residential location choices than traditional approaches. The authors also propose a method to measure the relative influence of each member on the household decision outcome.

SP methods represent a valid option to investigate residential location choices. This study belongs to the relatively small group of works employing an experimental SP approach. The main contribution is the combination of this experimental approach with two novel features of non-market SP evaluation. That is, we focus on the choice of dwelling and apply a group-based approach. The adoption of an experimental method avoids “yes saying” responses that

ignore actual trade-offs and merely produces declarative responses containing no valuable information. Conjoint choice analysis examines the trade-offs people make among attributes to assess the weight they assign to each of them[4].

Residential location choice has often been considered an ideal choice context to elicit agents' preferences for housing attributes. The motivations for this research strategy are due to the: 1) more direct perception of the issue at hand since the interview is explicitly connected to the present living situation; 2) realistic simulation of the decision-making mechanism agents adopt when choosing a dwelling; 3) credible evaluation of attribute variations.

2.4 From dyads to triads

Past research on household decision-making has, almost exclusively, focused on dyads alone considered as the (only) relevant household decision-making unit (Arora and Allenby, 1999; Bateman and Munro, 2005b; Beharry-Borg et al., 2009). For instance in Beharry-Borg et al. (2009) the dyadic couple is described as the basic decision-making unit. Understanding the role of third party influences, such as adolescents or other family members, on decision strategies is essential, in certain situations, to gain a broader view of the relevant unit of analysis. Decision-making in households, in fact, is influenced by the mere presence of children. This suggests joint family choices are qualitatively different from atomistic ones (Filiatrault and Ritchie, 1980). Spiro (1983) finds that the presence of children influences the use of persuasive techniques in the couple. There is also empirical evidence against the unitary household model in location choice among childless dyadic households (Mok, 2007). However, the author notes that in the presence of children there is not sufficient evidence to reject the parent income-pooling hypothesis.

[4] Examples of experimental choice studies on accessibility and environmental factors are profile based studies like Molin et al. (1999), ranking exercises such as Galilea and Ortùzar, (2005), Perez et al. (2003), Ortùzar and Rodrıguez (2002) Arsenio et al (2006), or a comparison between methods like Wardman and Bristow (2008).

2.5 Relative power analysis

Research suggests that a large proportion of the relevant decisions made by families are joint efforts by two or more family members (Davis and Rigaux, 1974; Samuelson, 1956). Various researchers from different fields have analyzed decision-making in households composed of individuals with non-identical preferences. Especially, research in marketing has modelled influence strategies in family decision-making (Davis, 1970; Shuptrine and Samuelson 1976). A common approach to measure the influence exerted by a member is to compare her initial preferences to the group's decision outcome. The degree of similarity between the first and the latter is taken as an indicator of the extent of influence (Corfman, 1989; Corfman and Lehmann, 1987). Recent empirical research conducted by Aribarg et al. (2002), Arora and Allenby (1999), and Arora (2006) present useful modelling approaches to measure individual influence at the attribute level in the context of group decision-making. This development is essential given the growing importance of techniques based on choices between goods and services with bundled characteristics.

The issue of obtaining accurate information concerning relative influence in family decision-making is still hotly debated and remains, mostly, unresolved. In the related literature, an array of methods has been suggested to evaluate the role of interaction. These are almost exclusively based on a questionnaire SP logic. In fact, data obtained from observed behaviour does not allow the detection of interaction effects. Research efforts such as Kirchelers' Diary method (Kirchler, 1995) and Arora and Allenby's attribute-specific influence measure (1999) are simply based on self-declared power measures. However, the literature has questioned this method of measuring power[5]. Moreover past research reveals a limited ability of single members to assess other member's preferences (Corfman and Lehmann, 1987; Dellaert et al. 1998; Menon et al. 1995). Analysing the role of children in influencing decisions is especially

[5] Corfman states that: "*Predictions and reports on relative influence made by spouses and observers are probably not valid indicators of relative influence. They may contain other useful information, but they are not objective measures.*" (Corfman, 1989, p 663).

complex. The papers considering it, generally based on declared influence, show that the children are aware of their influencing power while the parents, in general, underestimate it (Flurry and Burns, 2005). One needs to devise a method to uncover the unobservable so to obtain adequate SP data on household interaction. Authors such as Katz (1997) and Manski (2000) suggest that an experimental approach is needed to identify the heterogeneity of preferences and disentangle the intricacy of household decision-making[6]. Experiments have the advantage of allowing the researcher to produce data suitable to perform controlled tests of a theory.

3 Model and hypotheses

3.1 Base model of group choices

The various alternatives are described by a utility function of a general form. The model is kept simple to allow a meaningful comparison between individual and joint preferences. The impact of socio-economic interactions is not treated in the present work due to the considerable difficulties in computing them along with interaction effects and not because we regard their potential effects as marginal. On the contrary, a follow-up paper under way will explicitly address this specific issue. The general utility function used is the following:

$$U_{jk} = \beta_{1jn} SQ + \beta_{2j} RENT + \beta_{3j} ACC + \beta_{4j} AIR + \beta_{5j} NOISE + \varepsilon \qquad (1)$$

U_{jk} is the overall utility of the *j*th participant for *k* attributes in the experiment proposed to the four member-types (mother [M], father [D], adolescent [A] and joint-family-decision [F]). β_{1jn} is the coefficient of the constant capturing the intrinsic preference of the *j*th respondent for alternative *n* and β_{2j} - β_{5j} are coefficients. The disturbances, ε, are independent and identically distributed (IID) extreme value type I (Gumbel).

[6] In the words of Manski, "*Empirical analysis of social interactions would particularly benefit from performance of well-designed experiments in controlled environments and from careful solicitation of persons' subjective perceptions of the interactions in which they participate.*" (2000, p 117).

The variables to be estimated are the SQ (codified as a dummy = 1 when the current housing is chosen), RENT (measured in euro), ACC (measuring the access time in minutes), AIR (identifying the level of air pollution) and NOISE (level of noise).

While MNL is the most commonly used choice model, nonetheless it exhibits well-known restrictions that limit realism, particularly in cases where individuals have diverse preferences and behavioural attitudes (Hensher et al., 2005; Train, 2003). This fact may not be overlooked given the aim of assessing the preferences of different household members. In a MNL setting all member-types are assumed to exhibit a zero degree of random preference heterogeneity. In other words, the vector of βs merely reflects a sample mean. What is more, MNL assumes that individuals' unobserved utility is uncorrelated across alternatives and over repeated choices. In brief the factors explaining the unobserved utility are assumed to be perfectly random.

Mixed multinomial logit (MMNL) represents a major breakthrough in discrete choice (Hensher and Greene, 2003; Train, 1998). As implied by the name, MMNL is effectively a mixture of logits. The point of departure is a basic MNL that is brought to accommodate heterogeneity by iteratively taking draws of the estimated coefficients from a predefined underlying (mixing) distribution (e.g. normal, lognormal, triangular, etc.). This procedure is repeated numerous times and the outcomes averaged to produce the desired results.

3.2 Hypotheses testing: individuals and triads

At this stage we can consider response heterogeneity more rigorously. Binary comparisons of member-type responses allow us to test the hypothesis of preference equality for single attributes.

More formally we have:

H_0^{1a}, H_0^{1b} H_0^{1c}: the coefficients regarding single attributes are not pair-wise statistically different for each member-type. The null hypotheses to be rejected via a Wald test are the following[7]:

$$\begin{aligned} H_0^{1a} &: \beta_k^D = \beta_k^M \\ H_0^{1b} &: \beta_k^M = \beta_k^A \\ H_0^{1c} &: \beta_k^D = \beta_k^A \end{aligned} \tag{2}$$

We test the second hypothesis, concerning the validity of the *representative member* approach, in two different specifications.

In the first test specification, we control if the average family preferences (*pooled model*) can correctly represent joint household decisions. This is carried out via a modified log-likelihood ratio test that controls if the preferences of the pooled sample are an adequate representation of the single member sub-samples.

H_0^2: More formally we test the H_0^2 hypothesis by using a market segment test that compares the log-likelihood of the pooled model against the sum of individual log-likelihood models. The test statistic is then confronted with the critical χ^2 value corrected for the degrees of freedom (Koppelman & Bhat 2006). We want to reject the null of preference equality assumed by randomly interviewing respondents and ignoring member-type issues.

$$H_0^2 : \beta_k^{Pooled} = \beta_k^A + \beta_k^M + \beta_k^D \tag{3}$$

In the second instance, we check if single agent-type responses can aptly represent the joint post-discussion stated choices.

H_0^{3a}, H_0^{3b}, H_0^{3c}: we check whose single member-type preferences are the most representative of the joint family. This test will help individuating the most suitable respondent to interview for the aim of the study.

[7] It would have been possible to test the more restrictive hypothesis of $\beta_k^D = \beta_k^M = \beta_k^A$, however that approach provides less information concerning attribute and member specific preference heterogeneity/similarity.

$$
\begin{aligned}
&H_0^{3a} : \beta_k^{Family} = \beta_k^{A} \\
&H_0^{3b} : \beta_k^{Family} = \beta_k^{M} \\
&H_0^{3c} : \beta_k^{Family} = \beta_k^{D}
\end{aligned}
\tag{4}
$$

Based on these tests we will also estimate the bias implied by each hypotheses.

4 Data and sample description

4.1 Development of the stated choice experiment

4.1.1 Description of survey instrument

A SP experiment was administered to measure individual and household preferences for residential location. It was based on a pivoted design that presented two alternative housing bundles and the *status quo* situation. The hypothetical housing alternatives are related to the respondent-specific *status quo* and, more precisely, levels are expressed both in percentage around the revealed preference values as well as in discrete variations for the environmental attributes. The experiment was unlabeled. The reference *status quo* alternative is based on the levels stated by the respondents (see Appendix). This procedure was adopted since the arrival point for different respondents was not necessarily the same[8]. The *status quo* is inserted also to increase the degree of realism and to avoid artificially boosting the part worth utilities of the remaining attributes.

4.1.2 Attributes and levels

The levels of the attributes for the experiment are drawn from recent literature on residential choice. We include four attributes that are considered to be among the most influential in choosing a housing situation. The final selection consists of rent, air pollution, noise and accessibility to work/school. Table 1 illustrates these attributes and the levels used to describe them.

[8] This situation of course generates different travel times among members.

Table 1. Attributes and levels

Rent		**Air pollution**	
1	20 % lower than current	1	Very low level of emissions
2	10 % lower than current	2	Acceptable level of emissions
3	Same as current	3	Quite high emissions
4	10 % higher than current	4	Very high emissions
5	20 % higher than current		
Accessibility		**Noise**	
1	50 % less time to reach work/school	1	Quiet house
2	Same distance as currently	2	Low level of noise
3	50 % more time to reach work/school	3	Quite noisy
		4	Very noisy

A full profile, fractional factorial design was used to combine the attributes and levels. In the case of three alternatives, each having four attributes with three to five attribute levels each, where the number of combinations is $5\times3\times4^2=240$. Since it is impossible to show the full design to a single respondent the design was subdivided in 15 blocks where each choice set consisted of 16 choice tasks. Given the sample of 53 respondents of each member-type, the design was "covered" more than three times for each member-type.

4.2 Sequential survey administration

A two-step methodology was used to complete interviews with three-component families consisting of fathers, mothers, adolescents as well as the family (all members responding together). The choice tasks combined four attributes characterizing the residential localization denoted by a short definition. The conjoint design guarantees that choices take place between different profiles rather than single attributes thus avoiding abstract rating or ranking exercises. A summary of the explanatory variables is given in the Appendix.

The study involved the following three steps:

Step 1 (*pre-interview / individual task*): The interviewees answered questions on individual and family socio-demographic characteristics, attitudes and present housing

conditions. Each member conducted the interview without the presence of other members to avoid external influence.

Step 2 (*interview* / *individual task*): The first round of choice tasks was individual. The aim of this step was to elicit each member's preferences. Respondents were instructed to choose on the basis of their own preferences only. More in detail, they were told, "*In this part of the study we are interested in your opinion. We would like you to choose the housing alternative that you prefer the most.*"

Step 3 (*interview* / *group task*): The second round brought the members together and discussion was encouraged in order to reach a joint decision. The families, in this step, were instructed to jointly select an alternative. More specifically, they were told, "*We would like you to choose the housing alternative that you all can agree on among the following."*

Five adequately instructed university students interviewed 53 households. The interviews were face-to-face computer assisted (CAPI) and carried out in the home of the respondents. The students were trained in interview administration and instructed to find families living together and including, at least, one adolescent[9].

4.3 Description of sample

The sample consisted of 53 Italian households, implying that 212 interviews were carried out in total (4 member-types). The majority was located in the city of Rome and in the Friuli-Venezia-Giulia region. Most families included three (53% of the sample) or four (37%) members: mother, father and son/daughter. In families with more than 3 members, only 1 adolescent was interviewed. We consider this sampling approach, implicitly adopting a "representative child" hypothesis, a reasonable trade-off between accuracy and complexity (Kato and Matsumoto 2009). Further descriptive statistics are reported in the Appendix.

[9] Such a sampling procedure is not ideal from a statistical standpoint but proved a necessity due to the nature of the interviews and is in line with the procedure employed by Hensher et al. (2008).

5 Econometric results

5.1 MNL specification

A MNL was estimated as a reference model. Results are reported in Table 2. All estimations were performed using Nlogit 4.0 (Greene, 2007). In the first column of the table the variables are listed. A separate model for each member-type and for the joint household choice was estimated. For each model we report the value of the coefficients and *t*-statistics. Coefficients (β_{SQ}, β_{ACC}, β_{RENT}, β_{AIR}, β_{NOISE}) are all statistically significant and have the expected signs. The MNL is estimated using the absolute values for time and rent (Table 2). The stated levels of air pollution and noise are used to pivot the environmental coefficients.

Table 2. MNL model results

	Joint		**Individual preferences**					
	Family		**Son**		**Mother**		**Father**	
	Beta	**t-ratio**	**Beta**	**t-ratio**	**Beta**	**t-ratio**	**Beta**	**t-ratio**
Sq	1,096	8,94	1,153	9,65	0,818	7,15	0,893	8,09
Rent	-0,009	-9,44	-0,008	-8,96	-0,009	-9,62	-0,006	-7,77
Acc	-0,104	-9,21	-0,107	-9,68	-0,066	-6,42	-0,056	-6,82
Air	-0,839	-9,03	-0,573	-7,29	-0,886	-9,8	-0,852	-9,73
Noise	-0,535	-5,29	-0,513	-5,59	-0,534	-5,65	-0,396	-4,49
Summary statistics								
Obs	646		646		646		646	
LL*	-350,3		-386,1		-362,7		-389,3	
LL(c)	-573,7		-575,4		-593,1		-574,2	
Rho^2	0,389		0,329		0,388		0,322	
Rho^2 adj	0,387		0,326		0,386		0,319	

The SQ variable is coded 1 for the current housing and 0 otherwise. As such it expresses the desire to remain in the current housing situation along with the general influence of omitted variables (Train 2003). The results reported in Table 2 for each agent-type are not comparable due potential differences in scale. Comparability is achieved by scale correction, when appropriate, using the nested logit "trick" (Hensher and Bradley, 1993).

Table 3. Nested logit model results

	Family		Adolescent		Mother		Father	
Variable	**Coeff.**	**t-ratio**	**Coeff.**	**t-ratio**	**Coeff.**	**t-ratio**	**Coeff.**	**t-stat**
SQ	0,717	7,2	0,542	8,2	0,457	5,1	0,407	6
Rent	-0,007	-9,6	-0,004	-8,9	-0,007	-9,9	-0,004	-7,6
Acc	-0,069	-8,3	-0,051	-9,2	-0,039	-5,3	-0,028	-5,9
Air	-0,947	-12,1	-0,459	-10,3	-0,958	-13,1	-0,722	-13,1
Noise	-0,242	-3,1	-0,187	-3,9	-0,225	-3,3	-0,152	-2,9
Scale	1	fixed	0,676	18,5	0,925	18,7	0,724	18,8
Summary statistics								
LL*	-2314,894							
LL(c)	-3726,493							
McFadden Rsq	.725							

Table 3 indicates the adolescent has the most interest in *status quo* and accessibility. In line with results obtained by Molin et al. (2001), we believe that a plausible explanation of the high preference of the adolescent for the *status quo* might be that he/she has strong links with friends living in the immediate surroundings. Likewise the importance of accessibility is high for the adolescent. On the other hand the concern for the environmental aspects (noise and pollution) was, along with rent, most pronounced for mothers, whereas fathers are characterised by relatively low values of the βs for all attributes[10]. These observations may be associated with the set of H_0^1 hypotheses concerning the binary comparison of member type preferences. What is more they offer a first proof of the H_0^{3a} to H_0^{3c} comparing single members to the family, or joint, outcome. It may be noted that, although the mother has a similar scale factor to the family, not all coefficients are of the same entity.

5.2 MMNL and individual specific MMNL specification

Several studies have applied mixed multinomial logit (MMNL) to measure variation from unobserved sources. The MMNL specification was used allowing *status quo*, accessibility and air pollution to vary randomly across respondents and assumed to be normally distributed

[10] The scale factor for fathers is as low as that of the adolescent. This implies that the standard deviation of the observation is relatively high and there is a high degree of noise in the data. The mother is more akin to the response of the family with a high scale factor.

(Train, 1998). To avoid artificially suppressing heterogeneity no constraints were imposed on the distributions. The standard deviation of the noise parameter was not statistically significant in any of the models estimated. For WTP/WTA identification purposes the β_{RENT} was kept fixed. The results reported in Table 4 indicate that the introduction of housing attributes with random parameters improves the statistical fit compared to the MNL specification.

Table 4. Random parameters models

	Family		**Adolescent**		**Mother**		**Father**	
Variable	**Coeff.**	**t-ratio**	**Coeff.**	**t-ratio**	**Coeff.**	**t-ratio**	**Coeff.**	**t-ratio**
Rent (non r)	-0,014	-8,5	-0,009	-8,1	-0,014	-8,8	-0,009	-7,3
Noise(non r)	-0,983	-6,0	-0,771	-6,2	-1,155	-6,9	-0,745	-5,4
SQ (r.n)	1,427	5,0	1,150	5,4	1,179	3,8	1,140	4,4
SQ (st dev)	1,610	5,9	1,096	4,4	1,940	6,3	1,554	5,8
Acc (r.n)	-0,163	-6,6	-0,151	-6,2	-0,122	-5,0	-0,111	-5,7
Acc(st dev)	0,051	1,9	0,065	3,0	0,070	2,7	0,056	3,1
Air (r.n)	-1,957	-7,7	-1,131	-6,4	-1,693	-8,4	-1,674	-8,1
Air (st dev)	0,777	4,3	0,698	4,3	0,449	1,8	0,668	4,2
Summary statistics								
LL*	-287,505		-348,225		-300,531		-325,775	
LL (const.)	-698,717		-698,717		-698,717		-698,717	
Rsq	.467		.367		.468		.414	
RsqAdj	.463		.363		.464		.410	

All parameters in the model have the expected signs and are statistically significant. The standard deviation for each of the mixed coefficients was statistically significant at the 5% level. This indicates the presence of heterogeneity among all member-types regarding travel time, air pollution and the *status quo*. The results indicate that there is no underlying unitary preference structure in our sample in line with the rejection of H_0^{1a} to H_0^{1c}.

5.3 WTP/WTA estimates

The calculations of the WTP/WTA measures for the attributes show that there is no specific influence deriving from the model adopted. In fact the results of the MNL specification are

generally in line with those derived from the MMNL specification with the only exception being accessibility. Daily WTP/WTA measures are reported for facilitating interpretation since monthly rent is used as the *numeraire* (Table 5).

Table 5. WTP/WTA results

	MNL				RPL			
	Family	**Adol.**	**Mother**	**Father**	**Family**	**Adol.**	**Mother**	**Father**
SQ (€/level)	-4,07	-4,86	-3,11	-4,61	-3,33	-4,08	-2,79	-4,17
Accessibility (€/hour)	23,08	27,11	14,94	17,33	22,74	32,15	17,23	24,37
Air pollution (€/level)	3,12	2,42	3,37	4,40	4,56	4,01	4,00	6,13
Noise (€/level)	1,99	2,16	2,03	2,04	2,29	2,73	2,73	2,73

Notes: the WTA estimate is referred to the SQ while the remaining attributes are described as WTP, All values are referred to a daily WTP/WTA.

In the MNL specification, notwithstanding the fact that the mothers had the highest environmental coefficients, the fathers show a higher WTP for both noise and air pollution. Adolescents are characterised by a strikingly high WTP for accessibility and a relatively high WTA for the *status quo*.

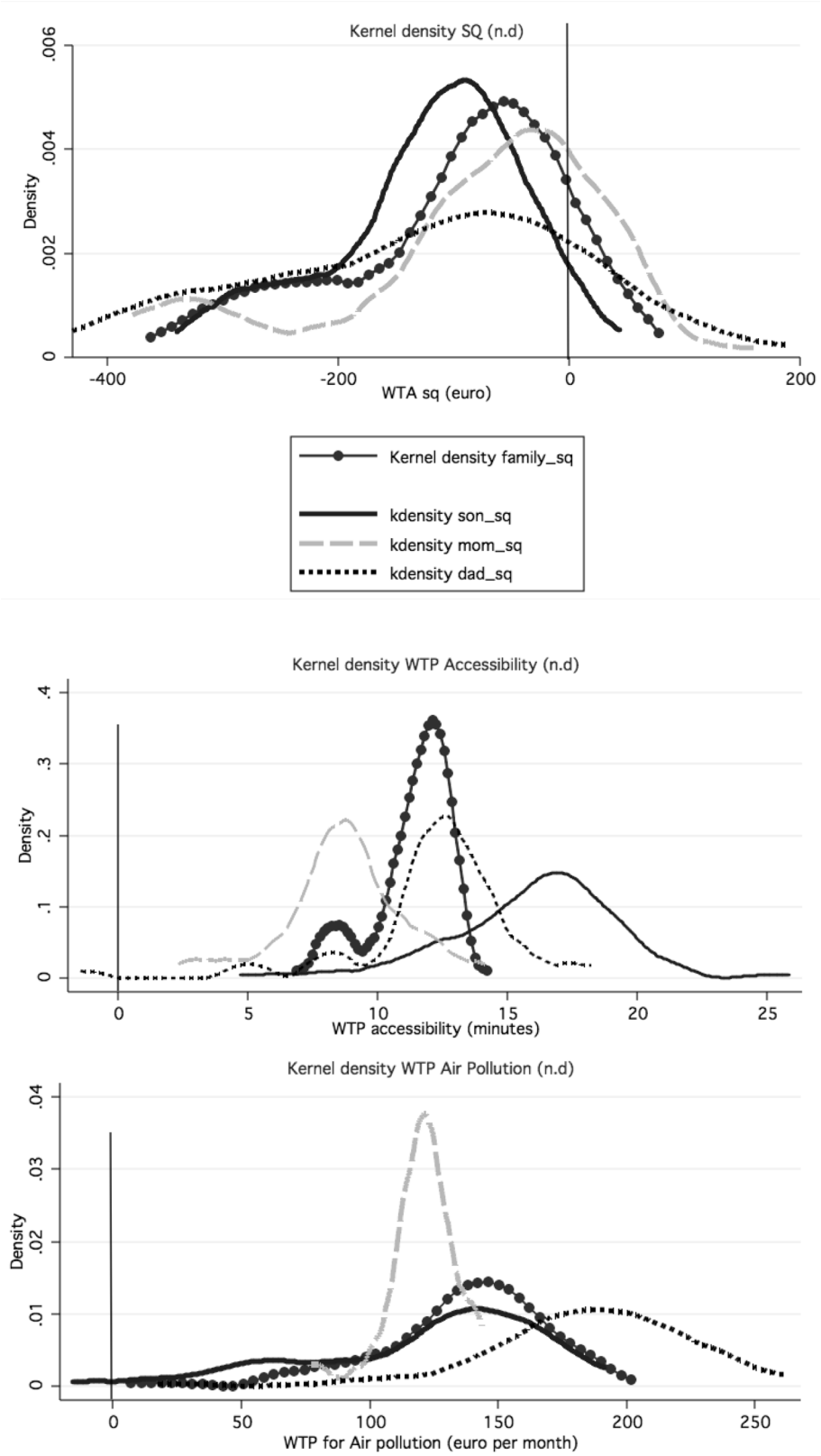
In the MMNL specification, similar results are obtained. WTP for accessibility coefficients are, on average, greater than in the MNL specification. The other noteworthy aspects are fathers' increased interest in air pollution, noise and *status quo*. The apparent loss of intensity in mothers' preferences is due to the pronounced interest this group has for rent, used as denominator in the WTP/WTA measures. Despite this, mothers appear to be the best predictor of the joint choice outcome.

5.3.1 Member and individual specific differences in WTP/WTA

In this paragraph we report the results for individual specific WTP/WTA estimates which are useful to compare the distribution of the various coefficients around the mean and show their relative dispersion. At the individual level the *status quo* attribute is, in general, not statistically different from zero and in line with the general *ex ante* expectation that not all the interviewees have a strong and common view of the *status quo* situation. As noticed earlier

adolescents have the highest WTP for *accessibility* as the kernel density confirms (see Figure 1). Fathers, in this case represent the joint family choice better, although mothers are also proximate. In other words the family outcome is *de facto* an average of the fathers and mothers WTP. All the coefficients are statistically significant and different from zero with the exception of the mothers; they are positive, as one would expect, notwithstanding the fact that no restrictions on the βs signs were imposed. Regarding WTP for decreasing the level of *air pollution* one notices that mothers have an extremely homogeneous evaluation of air pollution albeit with a lower mean value with respect to other member-types as controlled for in H_0^{1a} and H_0^{1b}. Adolescents' evaluations of air pollution are in line with those of the family while fathers have both the highest average values and the most spread out distribution. The WTP data show adolescents to be the least reliable proxy for understanding family preferences (several β's are non significant and some are even negative) implying the falsification of H_0^{3a}. Notwithstanding this, their final values are the most similar to that of the family. This is probably the average of fathers' and mothers' preferences.

Figure 1. Kernel – Conditional distributions of marginal WTP



Heterogeneity in the sample indicate considerable preference differences both among member-types as well as within them. Thus, we implicitly consider the set of H_0^{1a} to H_0^{1c} hypotheses rejected. In more detail, in the case of air pollution, mothers could well be treated by adopting a "representative mother" hypothesis. On the contrary, adolescents and fathers are both distinctly different from mothers for this attribute and there is evidence of substantial disagreement within these groups in line with the rejection of H_0^{1a} and H_0^{1b}.

5.4 Similarity and relative power

Similarity is a proxy for relative power. Similarity between a member-type *ex-ante* preferences and the joint *ex-post* ones indicates that this member-type has a higher relative power over the joint decision. In fact, this signals that the other household members accepted a larger deviation from her preferred choice outcomes. This logic is commonly used in studying dyadic decisions where there is no ambiguity as to who prevails. However, with more than two participants, identification of the source of relative power is more complex. In fact, an intermediate position between two extremes could be explained in two different ways. It may indicate power equality or, on the contrary, it may be due to the dominance of a member that happens to lie in the middle of the extreme preferences.

Table 6. Standard deviation between family and single members (MMNL normal dist.)

	WTP sq	**WTP acc**	**WTP air**
Adolescent	0,387	-1,431	0,358
Mother	-0,260	0,826	0,324
Father	0,431	-0,231	-1,132

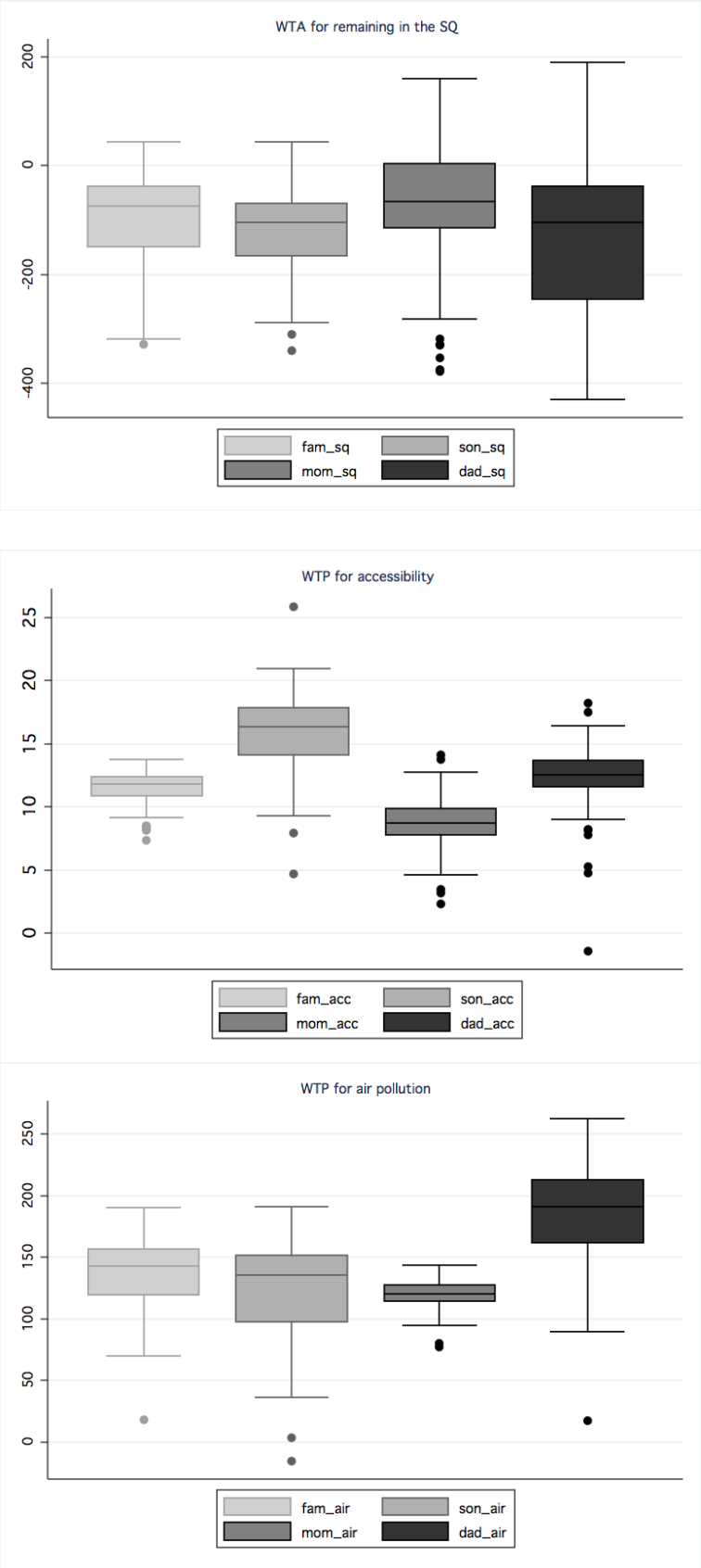
Table notes: The absolute values reported are the delta between the family and each member-type WTP/WTA βs in terms of standard deviations of individual estimates. The sign represents the distance (positive or negative) that the family has compared to each single member.

The data reported can be used as a formal description of the proximity of each member-type to the joint choice outcomes. For example, fathers are more willing to pay for accessibility (24,37 €) than the family as a whole (22,37 €) but they are also the best single member-type

predictors for this attribute. In fact, the WTP standard deviation of fathers from the family is the smallest (-0,23 above) compared to mothers (0,82 below) and adolescents who are 1,43 standard deviations above the family (see Table 6). Considering air pollution one can observe that fathers are furthest away from family preferences (1,13 stnd. dev. above). Instead, mothers and adolescents have similar positions (0,32 and 0,36 stnd. dev.) but below family estimates.

In general relative power analysis can be complicated in the case of three-member families. This is due to the intricate identification of the source of power. In fact, to determine the relative power of each member-type we cannot solely rely on similarity but also need to account for *ex-ante* preference intensity. An emblematic example of this point, in our sample, is adolescents' influence over air pollution. Despite the fact that adolescents show a limited interest for this attribute according to the previous measure of similarity adopted, one could mistakenly interpret this as a result of relative power. However, we are convinced that the final result is most probably due to reconciliation between fathers' and mothers' distinctly different preferences averaging out over adolescents' intermediate position. The amount of noise inherent in each member-type's preference, as opposed to the occurrence of adventitious similarity, may also be studied in the reported box-plots (Figure 2).

Figure 2. **Box-plots of Individual specific WTP/WTA**



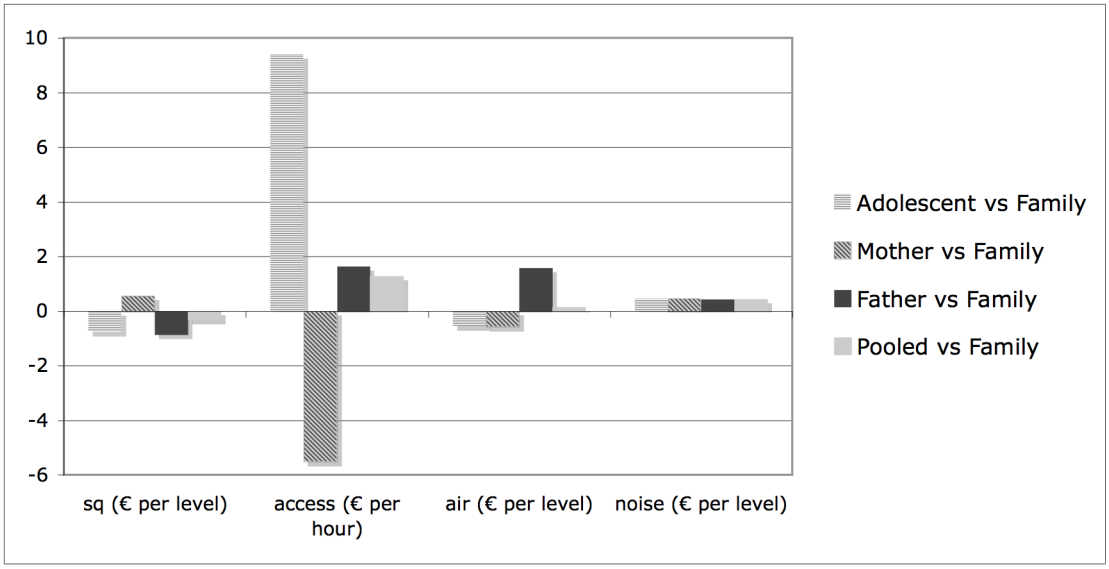
Notes: sq is referred to the status quo value, acc indicates accessibility and air stands for air pollution. The unit of measurement is the monthly WTP/WTA

In the box-plot diagrams it is possible to discover member specific data spread, as well as similarity in the median. For instance the mothers' WTP for access and air pollution abatement are both quite concentrated around the mean and, at the same time, similar to those of the family. This finding offers ulterior evidence towards the H_0^{3b} hypothesis.

5.5 Quantifying the bias of the "representative member" hypotheses

In this paragraph we illustrate the potential bias induced by an uncritical adoption of the representative member hypothesis. These considerations might be extremely important for policy evaluations. We compare the family WTP/WTA values, derived from the MMNL, with those of each member-type as well as with the pooled sample.

Figure 3. Illustration of WTP/WTA bias based on MMNL WTP



The use of a randomly selected sample of family member-types would provoke an up-ward bias for accessibility (1,27 €). For the other attributes there is no relevant distortion. On the other hand the comparison between single member-types and the family data reported give us an idea of the entity of the over- or under-estimation bias introduced were we to use the targeted sample strategy. For instance in the case of studying accessibility by targeting

mothers we would underestimate the WTP for accessibility by 5,50 € per hour. By targeting adolescents for accessibility one would over-estimate by 9,41 € per hour. Based on our results only noise could be aptly studied by targeting any member-type.

6 Summary and conclusions

The representative member hypothesis has, since long, been the cornerstone of household analysis. Its validity has only recently been questioned. In fact, analysts have generally treated the household as if it were an individual, a single economic unit without much interest as to what went on within it. Theory building and policy definition assumed households to have a single set of preferences. Were this true, inquiring the preferences of a single individual would be sufficient to model family ones. This approach is acceptable if either the representative member adequately describes other members' preferences or if she holds the power over a certain decision. Research findings, in the last decades, cast doubts over these assumptions. What is more, families make influential decisions jointly. This makes it difficult to locate an individual that is solely responsible for the decision (Davis and Rigaux, 1974). Traditional indicators, such as relative income, may prove poor proxies for ability to influence choices. Past empirical research point to large differences between individual and joint choices (Arora and Allenby 1999, Beharry-Borg et al. 2009; Corfman and Lehmann 1993; Dellaert et al. 1998; Molin et al. 1999;). When families decide jointly in the presence of heterogeneity we need to consider novel methods to detect preference disparity. Lastly, if single members were able to describe the preferences of the family, then we might still be able to salvage the traditional representative member approach. However, studies find a weak ability to assess other members' preferences (Corfman and Lehmann 1987; Menon et al. 1995) and a limited capacity to predict own influence over joint choice (Dellaert et al. 1998). So, what is done in this paper to analyze interactive family decision-making keeping these critical comments in mind?

The paper tests three hypotheses. We first reject the hypothesis that there is no significant preference heterogeneity at the attribute level both among and within different member-types. Subsequently, we test the representative member hypothesis to assess whether the utility functions of single respondents differ from the pooled or post-discussion group utility. SP studies typically interview single members to gather "representative" information regarding collective preferences. The shortcomings of the representative member assumption are revealed in two specifications. Firstly we test the null that the pooled choices correctly reveal the preference structure expressed in the joint choice (H_0^2). Secondly we analyse the coefficients of member-types and compare them to family responses. This allows us to discover to what extent they agree on the priorities for the different attributes ($H_0^{3a}, H_0^{3b}, H_0^{3c}$). For H_0^2 a log-likelihood ratio test shows that the pooled version of the sample is not a statistically valid representation of individual answers[11]. For H_0^{3a} to H_0^{3c} looking at the box-plot reported in Figure 2 one can appreciate the difference in WTP/WTA distribution among member-types.

Finally, we quantify the WTP/WTA bias inherent in the uncritical adoption of the representative member hypothesis. This is illustrated for both the specific and average member-type hypotheses.

It is important to associate these findings with the sampling strategies used in household research. By analyzing the coefficients of the members and comparing them to family responses one can understand to what extent family members agree on the relevance of the different attributes in line with the second sampling approach (see par. 2.2) tested in hypothesis H_0^{3a} to H_0^{3c}. That is, if a specific single member adequately represents family

[11] Indeed the test of the equality between the pooled model against the sum of individual models yields a test statistic of 36,16 to be compared against the critical χ^2 value (at 95%) of 25.

preferences, as in H_0^{3c} then the representative member assumption cannot be rejected and interviewing only that specific member would cause no distortion. This implies that interviewing both single member-types as well as the family, as described in the fifth sampling approach would not be resource-efficient.

Alternatively, one may test the null that it is the pooled choices to reveal the correct preference structure in line with sampling approach n°1. This implies that randomly selecting mothers, fathers and adolescents would not generate particularly biased estimates of household utility (H_0^2).

In view of the results from our sample, concerning the rejection of the hypothesis of the representative member, we conclude that a further investigation of the fifth sampling approach is justified.

Finally we discuss the implications of modelling three-member households. In this paper similarity in preferences between the family and single members is used as a proxy for influence. However the issues of identification of influence is made complex by accidental similarity in part-worths, in particular for the case of the adolescent. Although at first gaze this might be interpreted as relative power we need to carefully consider the position of all members that contribute towards the family choice. It is, indeed not possible to exclude the prospect that the final result is due to reconciliation between fathers' and mothers' distinctly different preferences averaging out near the adolescents' intermediate position.

Future research will: explore more cost efficient and empirically robust sampling strategies; test different mixing distributions and truncations for random parameters; develop advanced methodologies to study relative power in a triadic context; research and identify agent-specific, choice-specific and latent variables to segment the respondents.

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Appendix

			Family		Adolescent		Mother		Father	
	Variable	*Unit*	*Average*	*StDev*	*Average*	*StDev*	*Average*	*StDev*	*Average*	*StDev*
Socio-economic characteristics	Age	Average	-	-	22,47	6,45	49,96	9,28	54,06	6,68
	Sex	% female	-	-	47%	:	100%	:	0%	:
	Rent	Euro	696,99	366,18	694,79	365,80	700,45	365,84	695,74	367,85
Current housing	Current access time	Minutes	-	-	20,34	15,33	19,21	16,30	23,25	19,18
	Acceptability current access	Level 1-3	-	-	1,28	0,53	1,23	0,54	1,23	0,47
	Current pollution level	Level 1-5	-	-	1,74	1,08	1,68	1,07	1,68	1,01
	Acceptability of current pollution	Level 1-3	-	-	1,28	0,63	1,32	0,67	1,34	0,65
	Current noise level	Level 1-5	-	-	1,49	0,75	1,62	0,84	1,57	0,82
	Acceptability of current noise	Level 1-3	-	-	1,15	0,41	1,19	0,52	1,17	0,43
Travel mode	Travel Mode: by foot	%			15%		23%		21%	
	Travel Mode: by PT	%	-	-	30%		26%		21%	
	Travel Mode: by car	%	-	-	43%		47%		60%	
Policy intervention	Pro political intervention	% yes	-	-	38%		43%		34%	
Schooling	Secondary School	%	-	-	28%		17%		23%	
	High School	%	-	-	38%		49%		45%	
	University	%	-	-	32%		32%		32%	
Employment	Employee	%	-	-	38%		70%		62%	
	Student	%	-	-	62%		0%		0%	
	Freelancer	%	-	-	0%		15%		32%	
Attribute importance	Importance Noise	Level 1-5	4,40	0,79	4,11	1,15	4,42	0,84	4,34	0,96
	Importance of Air pollution	Level 1-5	4,43	0,75	4,19	1,09	4,51	0,85	4,47	0,80
	Importance of Access to work	Level 1-5	4,17	0,78	4,23	0,89	3,89	1,10	3,64	0,90